

COMBINATION FILTER/CARTRIDGE ASSEMBLYCROSS-REFERENCE TO RELATED APPLICATION

Applicant hereby claims priority based on U.S. Provisional Application No. 60/243,918 filed October 27, 2000, entitled "Combination Filter/Cartridge Assembly," which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to air-purifying filter cartridge assemblies and in particular to a combination filter/cartridge assembly containing a particulate filter media in series arrangement with a sorbent bed.

20 BACKGROUND OF THE INVENTION

Cartridge filtering assemblies have been described previously in the art. One such assembly U.S. Patent No. 4,548,626 to Ackley, discloses a combination of a radially pleated filter and a sorbent bed. This invention does not disclose a support between the round filter and the sorbent bed having radially directed vanes for distributing air over the sorbent bed. Thus, the airflow through the sorbent bed may be short circuited and cause premature exhaustion of the bed.

U.S. Patent No. 6,044,842 to Pereira et al., discloses a gasketless adapter for fastening two filter elements to one another. However, the geometrical structure of the arrangement of the first and second does not allow for full utilization of the filtering capability and may cause excessive pressure drop.

U.S. Patent No. 4,714,486 to Silverthorn, discloses a filter canister having a canister body with top and

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5 bottom parts sealed together, a filter for particulate
material sealed into the top part and a separate sorbent
cartridge fitted into the bottom part of the body. The
design of the prior air filter cannister does not allow
for uniform air distribution throughout the plenum
10 chamber between the first and second filters which is an
undesirable attribute of the design.

Therefore, as can be seen from the prior art
patents, there is a need for a novel filter cartridge
assembly which can be used with one or more filter
15 assemblies and thus provide for structure bed integrity
and for uniform distribution of air throughout the
assembly.

SUMMARY OF THE INVENTION

20 The present invention meets the above-described
need by providing a housing that combines with a
particulate filter having an irregular shaped gas
sorbent bed. Proper usage of the filter cartridge
requires that the air passing through the filter be
25 distributed uniformly over the sorbent bed. Thus, the
filter cartridge directs the air radially over the
surface of the sorbent bed utilizing the vane-like
structures radiating out from the reticulated members. A
multi-functional assembly located within the filter
30 housing has been named a replendam. The term
"replendam" is an acronym for an assembly which is a
retention screen, a plenum chamber, and an adhesive
barrier for a particulate filter.

As a retention screen, it provides stability to the
35 sorbent bed to ensure individual grains of sorbent do

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5 not move or otherwise shift in the sorbent column.
Errant settling or shifting of the sorbent changes the
flow characteristics of the bed and effects essential
residence time of the gases that the bed must absorb.

As a plenum chamber, it ensures that the face
10 velocity across the sorbent bed is uniform.

As an adhesive barrier, it prevents migration of
glue into the plenum when the particulate filter is
potted in place. Since the immobilization screen must
apply pressure evenly, the adhesive barrier must be
15 designed to allow a cushion so the filter area under it
is not crushed.

The foregoing and additional advantages and
characterizing features of the present invention will
become clearly apparent upon reading of the following
20 detailed description together with the included
drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of the combination
25 filter/cartridge assembly of the present invention.

Fig. 2 is a side elevational view of the
combination filter/cartridge assembly of Fig. 1.

30 Fig. 3 is a partially cutaway side elevational view
of the combination filter/cartridge assembly.

Fig. 4 is a detailed partial view of the
combination filter/cartridge assembly shown in Fig. 3.

5 Fig. 5 is a detailed partial view of the
combination filter/cartridge assembly shown in Fig. 3.

Fig. 6 is a perspective view of the replendam.

10 Fig. 7 is a bottom plan view of the replendam.

Fig. 8 is a cross-sectional view taken along line
8-8 of Fig. 7.

15 Fig. 9 is a cross-sectional view taken along line
9-9 of Fig. 7.

Fig. 10 is a detailed partial view from Fig. 9.

20 Fig. 11 is a perspective view of the cover.

Fig. 12 is a top plan view of the cover.

Fig. 13 is a side elevation view of the cover.

25 Fig. 14 is a bottom plan view of the cover.

Fig. 15 is a sectional side elevational view of the
cover.

30 Fig. 16 is a detailed partial sectional view of the
cover.

Fig. 17 is a perspective view of the body.

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5 Fig. 18 is a top plan view of the body.

Fig. 19 is a sectional side elevational view of the body.

10 Fig. 20 is a bottom plan view of the body with the reticulated wall removed for clarity.

Fig. 21 is a top plan view of an alternate embodiment of the present invention.

15 Fig. 22 is a side elevational view of an alternate embodiment of the replendam of the present invention.

20 Fig. 23 is an alternate embodiment of the cover of the present invention.

DETAILED DESCRIPTION

Now, referring to Figs. 1-23 generally and initially to Fig. 1, a combination cartridge/filter assembly 10 of the present invention is shown. The assembly 10 includes a particulate filter media 13 (Fig. 4) and a sorbent bed 16 (Fig. 4). The sorbent bed 16 is formed out of a sorbent media 17 that may include carbon materials comprising impregnated carbon and/or activated carbon. Other granular sorbent materials may also be suitable. Also, any materials that are air permeable and that are capable of absorbing or reacting with the gas contaminants to be removed or neutralized would also be suitable. The filter media 13 and the sorbent bed 16 are disposed in a series arrangement with a relatively

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5 small plenum chamber disposed between the filter media
13 and the sorbent bed 16 as will be described herein.
The assembly 10 comprises a cover 19 that snaps onto a
body 22. The cover 19 includes a grill or reticulated
wall 23 spanning an opening 24. The filter media 13
10 fits inside the cover 19 and is separated from the
sorbent bed 16 by a replendam 25 (Figs. 4 and 6-10) as
described below. The cover 19, body 22, and replendam
25 are formed out of suitable thermoplastic materials in
injection molding processes or the like. Other
15 materials having suitable properties for use as a filter
cartridge and replendam may also be used.

In Fig. 2, the cover 19 has an air inlet 28 where
ambient air is drawn into the assembly 10 for
purification. The assembly 10 is suitable for use with
20 a respiratory mask of the type disclosed in U.S. Patent
No. 6,016,804 which is assigned to the assignee of the
present invention and which is incorporated herein by
reference. The outlet 31 of assembly 10 attaches to the
inlet of a respiratory mask.

25 Turning now to Fig. 3, the path for the flow of air
is indicated by arrows 34 and 37. The particulate
filter media 13 is a round pleated filter media. Other
particulate filters may also be suitable and other
shapes of filters may also be suitable. The body 22 for
30 the sorbent bed 16 is significantly larger than the
filter media 13 and has an irregular six-sided shape.
However, the number of sides and the shape of the
sorbent bed 16 is not critical.

In Fig. 4, the cover 19 houses the particulate
35 filter media 13 which as described above is typically a

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5 round pleated filter media. The pleated filter media 13
is potted in the cover 19 as will be described in detail
hereinafter. The inside of the cover 19 in cooperation
with the bottom surface of the media 13, the replendam
25, and the top of the sorbent bed 16 forms a plenum
10 chamber 40 between the filter media 13 and the sorbent
bed 16 which is located in body 22. The replendam 25
maintains separation between the filter media 13 and the
sorbent bed 16 to form plenum chamber 40. Also, the
replendam 25 applies pressure to immobilize the sorbent
15 bed 16 when the cover 19 is snapped onto the body 22 as
will be described in detail hereinafter. In part, the
immobilizing pressure is applied through a plurality of
plastic springs 41 which will be described in detail
hereinafter. The replendam 25 engages with a retention
20 filter media 43 disposed over the sorbent media 17. The
last layer inside the body 22 is a second retention
filter media 49, which is preferably a fines filter that
may be placed in the bottom of the body 22 or attached
to the bottom of the body 22 by sonic welding, glueing,
25 or other process.

As shown in Fig. 4, the perimeter of the replendam
25 has a V-shaped rib 50 extending downward toward the
sorbent bed. Above the V-shaped rib 50, the replendam
25 has a V-shaped groove 53 disposed therein. A
30 corresponding V-shaped rib 56 disposed on the cover 19
engages with the groove 53 when the cover 19 is snapped
onto the body 22. The cover 19 has a second V-shaped
rib 59 that engages with a V-shaped groove 62 disposed
in the upper edge of the side wall 65 of the body 22.
35 The cover 19 also includes a hook portion 68 (best shown

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5 in Figs. 5 and 16) that snaps over a shoulder 71 (best shown in Fig. 19) formed in the outside top of the side wall 65 of the body 22.

Turning to Fig. 5, a sealing compound 74 is applied in a bead to the area around the V-shaped rib 59 to seal the joint where the rib 59 engages with the groove 62 (Fig. 4) in the body 22.

In Figs. 6-10, the replendam 25 includes a grill or reticulated wall 80 that is round to correspond to the shape of the filter media 13. Other shapes for different shaped filter media would also be suitable. An air dam 83 is disposed in substantially parallel and spaced apart relation above the reticulated wall 80. The air dam 83 is also round to correspond to the shape of the filter media 13, however, other shapes for non-round media would also be suitable. The air dam 83 acts as a adhesive barrier when the filter media 13 is potted in the cover 19 as described herein. Air dam 83 is attached to the reticulated wall 80 by a plurality of first inner legs 86 of the plurality of springs 41 (best shown in Fig. 10). In the embodiment shown, there are eight springs 41 that are approximately equidistant around the circumference of the reticulated wall 80. The springs 41 are U-shaped with the first legs generally designated as 86 being attached to the air dam 83 and the second outer legs generally designated as 88 being attached to a circular inner support frame 89 (Fig. 7). The circular or round inner support frame 89 is disposed substantially coplanar with the reticulated wall 80. The inner support frame 89 is circular or round for the round filter media 13, however, it could

5 be other shapes for non-round media. As best shown in
Fig. 10, the outer frame 95 extends below the plane
formed by the reticulated wall 80, the inner frame 89,
and the support members 92 so that the outer frame 95
makes the initial contact with the retention filter
10 media 43. The plurality of lateral support members 92
attach the inner support frame 89 to an outer frame 95
forming a second reticulated wall 93 that conforms to
the six-sided shape of the body 22. A plurality of
vane-like members generally designated as 100 extend
15 from the center of the reticulated wall 80 and connect
between the inner support frame 89 and the outer frame
95. As shown the vane-like members 100 extend radially
in substantially straight lines. For non-round filter
media, the vane-like members 100 may be straight or
20 curved depending on the filter geometry and may or may
not extend radially. The vane-like members 100 extend
vertically above the support members 92 between the
horizontal planes defined by the reticulated wall 80 and
the air dam 83. The vane-like members 100 are connected
25 by a pair of curved members 101, 102 that are concentric
with the inner frame member 89. The vanes 100 direct
the air flow and also function as stiffening ribs for
applications where sorbent bed immobilization is
required so that energy can be transferred through the
30 springs 41 across the replendam 25.

In Fig. 10, the V-shaped rib 50 and the V-shaped
groove 53 of the replendam 25 are shown with relation to
one of the springs 41 located at the side of the
replendam 25. The first leg 86 of the spring 41 extends
35 to the reticulated wall 80 and the second leg 88 extends

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5 to the inner support frame 89. A short lateral support
member 92 connects the inner support frame 89 to the
outer frame 95. As described above the outer frame 95
conforms to the six-sided shape of the sorbent bed 16.
The outer frame 95 is formed with the V-shaped rib 50 on
10 the bottom and with the V-shaped groove 53 on the top.

In Figs. 11-16, the cover 19 is shown in greater
detail. The cover 19 has a complex shape with a round
section 110 extending outward from a six-sided planar
section 113. The round section 110 corresponds to the
15 shape of round filter media 13. Other shapes for
section 110 for use with non-round filters would also be
suitable. The six-sided planar section 113 terminates
in side walls 115 that extend substantially
perpendicular to the planar section 113. In Fig. 12,
20 the opening 24 is covered by the grill or reticulated
wall 23.

The round filter media 13 (Fig. 4) is potted in the
round section 110 by applying a glue 111 (best shown in
Fig. 4) to the perimeter of the filter media 13 such
25 that air is prevented from passing around the edges of
the filter media 13 between the media 13 and the inner
wall of the cover 19. As shown in Fig. 4, the air dam
83 acts as a adhesive barrier to prevent glue from
entering the plenum chamber 40.

30 In Fig. 16, the hook 68 and the first and second V-
shaped ribs 56, 59 are shown in greater detail. Also
shown is an inner wall 116 that extends downward for a
short distance and surrounds the round section 110 for
the round filter media 13. As shown in Fig. 15, the
35 wall 116 has openings generally designated as 117

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5 defined therein that are sized to receive the springs 41
that extend toward the air dam 83 when the replendam 25
is installed in the cartridge assembly 10. When the
replendam 25 is installed in the assembly 10, the air
dam 83 fits inside the inner wall 116, and the V-shaped
10 groove 53 in the replendam 25 engages with the first rib
56 (best shown in Fig. 4).

Figs. 17-20, illustrate the body 22 in greater
detail. The body 22 has a set of ribs generally
designated as 120 disposed on a bottom surface 123. The
15 ribs 120 are designed to channel the air flow toward the
outlet and to assist in the immobilization of the
sorbent materials 46. The bottom surface 123 is
substantially planar and is shaped in a six-sided shape.
Other shapes may also be suitable. The bottom surface
20 123 is bordered by a plurality of side walls 65 that
extend substantially perpendicular to the bottom surface
123 to form a chamber.

In Fig. 18, the outlet 31 has a grill or
25 reticulated wall 140 that supports the sorbent bed 16.
Turning now to Fig. 19, the body 22 has an opening 145
that is disposed in spaced apart relation to the
reticulated wall 140. The opening 145 has a pair of
truncated sides 148 that provide for inserting a
30 quarter-turn bayonet mount adapter such as disclosed in
U.S. Patent No. 6,016,804 through the opening. The
space between the opening 145 and the reticulated wall
140 provides clearance for the adapter on the
respiratory mask to fit inside the cartridge assembly 10
35 and to turn into a locked position.

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5 As shown in Fig. 19, the side walls 65 have
shoulder 71 extending around the periphery of the top
edge 133 of the side walls 65. As described above, the
shoulder 71 cooperates with the hook 68 on the cover to
provide for a snap-fit.

10 In Fig. 20, the opening 145 is shown with the
reticulated wall 140 removed such that the sides 148 are
clearly shown. The opening 145 is designed with sides
148 such that the assembly 10 is capable of mounting
onto a respiratory mask by means of a quarter turn
15 bayonet adaptor of the type disclosed in U.S. Patent No.
6,016,804.

 In operation, the combination filter/cartridge
assembly 10 performs several functions. Returning to
Fig. 4, the replendam 25 serves several functions.
20 First, the replendam 25 is sized such that the bottom
surface provides an immobilization force when the cover
19 is snapped onto the body 22. When the cover 19 is
snapped onto the body 22, the bottom of the round filter
media 13 engages with the air dam 83 to provide a
25 downward force against the sorbent bed 16. The force is
transmitted through the springs 41 to the entire bottom
surface of the replendam 25 such that an immobilization
force is applied throughout the bottom surface of the
replendam 25 onto the top surface of the sorbent bed 16.
30 Also, the rib 50 disposed around the perimeter of the
replendam 25 is forced downward onto the retention
filter 43 when the cover 19 is snapped onto the body 22.
The rib 50 provides a knife edge engagement with the
retention filter media 43 that holds the media 43 in
35 position.

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5 Accordingly, the force of the replendam 25 on the
top of the sorbent bed 16 promotes sorbent pack density
and stability. As known to those of ordinary skill in
the art, the settling or shifting of sorbent changes the
flow characteristics of the bed and effects residence
10 time of the gases that the bed must absorb.

 In addition to transmitting force to the bottom
surface of the replendam 25 through the springs 41, the
air dam 83 also provides a adhesive barrier to prevent
the glue that is used to pot the filter media 13 in the
15 cover 19 from entering the plenum chamber 40.

 Returning to Fig. 7, the design of the replendam 25
also promotes uniform distribution of air over the
sorbent bed 16. The plenum 40 is designed to provide a
chamber where equalization of the air flow can occur
20 prior to entry of the air into the sorbent bed 16 such
that the sorbent bed 16 surface uniformly receives air
having the same or approximately the same face velocity.
Uneven distribution of airflow will underutilize the
sorbent bed 16 and decrease the bed life. Also, the
25 radial vane-like structures 100 of the replendam 25
direct the air flow in the plenum chamber 40 over the
entire surface of the sorbent bed 16 to promote uniform
distribution of air flow across the bed.

 The embodiment shown in Figs. 1-20 provides a
30 replendam 25 for use between filter media 13 and sorbent
bed 16. However, the replendam 25 of the present
invention could also be disposed between two different
sized filter media or a multi-stage cartridge could be
constructed with more than one replendam 25 disposed in
35 combination with filter media and/or sorbent beds.

5 Also, the springs 41 may be utilized in a single
stage filtering system such that the device would not
include the vanes 100 and the plenum chamber 40. For
example in an alternate embodiment shown in Fig. 21, the
springs 41 could engage with an alternate cover 200
10 (Fig. 23) such that the springs 41 could be used to
transmit a force from the cover 200 to the retention
filter 43 through the outer frame 95 and the reticulated
structure 201 above the sorbent bed 16. The cover 200
has an irregular-shaped opening. As an alternative, the
15 cover 200 could be provided with a round, smaller
opening such as the opening covered by a reticulated
wall shown in Fig. 11. Accordingly, the smaller round
opening would facilitate an easy negative pressure check
by the user of the device who would be able to cover the
20 opening with one hand.

 In certain applications the force on the sorbent
bed transmitted through the springs 41 to the replendam
25 may not be required. These applications may include
situations where the replendam 25 is disposed between
two filters or if the sorbent does not require the force
on the top of the bed.

 Also, in another alternate embodiment for forming a
plenum, an alternate replendam 300 shown in Fig. 22
could be constructed without plastic springs generally
30 designated as 41. The replendam 300 could have the
adhesive barrier air dam 83 connected to the inner
support member 92 by means of a solid member 303 without
spring properties. Accordingly, the springs 41 and the
design of the replendam 25 may or may not be used in
35 combination depending on the application.

5 While the invention has been described in
connection with certain embodiments, it is not intended
to limit the scope of the invention to the particular
forms set forth, but, on the contrary, it is intended to
cover such alternatives, modifications, and equivalents
10 as may be included within the spirit and scope of the
invention.

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